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Comparative Study of Different Management Practices for Cotton Cultivars against Dusky Cotton Bug (*Oxycarenus Spp.*)

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ABSTRACT

The present study was carried out to compare the damage assessment of dusky cotton bug (Oxycarenus laetus Kirby) among four cotton cultivars (VH 305, VH 363, VH 327, and FH 183) by using three different management practices including chemical and non-chemical control. The population dynamics of dusky cotton bug (DCB) in cotton cultivars were determined during 2017-18 under field conditions in the area of Cotton Research Station, Vehari. Three different management practices (treatments) were taken such as chemical control (using two different chemicals imidacloprid and chlorpyriphos) sprayed, unsprayed (growth and damage pattern under natural field conditions), and non-chemical using a net cloth to ensure the avoidance of insects. Both qualitative and quantitative parameters are taken under this study. Quantitative parameters are affected on large scale by the DCB viz., seed cotton weight (42.92%), seed weight (40.84%), and oil content (35.16%) were taken under unsprayed conditions. It can feed on the seed so due to this reason also called a seed bug. Results have been revealed that the germination percentage was on the peak under sprayed condition followed by net cloth treatment and lowest germination showed by unsprayed treatment. The study is helpful for all cotton growers especially in area with the supportive environmental condition as higher relative humidity. The cotton minor pests including dusky cotton bugs change their status by increasing the population during the supportive abiotic factors, especially temperature and humidity. As our weather conditions are usually supportive to insects' maintenance of a higher population in the field helps the pest to keep their population above damaging boundaries.

Keywords: *Comparative, cotton cultivars, management, Imidacloprid, chlorpyriphos, Dusky cotton bug*

Introduction

Cotton technically known as *Gossypium hirsutum* L. is grown almost all over the world and grown in Pakistan as a cash crop. It contributed almost 7.8 percent of value-added in agriculture and 1.6 percent of GDP (Pakistan, 2016). Cotton produces the raw material for the domestic and international textile and oil industry, also its value-added products can be exported and earn a lot of foreign exchange (Abbas, Hassan, Farhan, Haq, & Karar, 2015).

During 2017-18, cotton production stood at 11.935 million bales and recorded growth of 11.8 percent over the production of 10.671 million bales during the same period last year. Cotton crop has a 1.0 percent share in GDP and contributes 5.5 percent in agriculture value addition.

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The cotton crop was cultivated on an area of 2,699 thousand hectares compared to the year's area of 2,489 thousand hectares, showing an increase of 8.4 percent (Pakistan, 2016). The production of cotton is lower than the standards and the other countries due to both qualitative and quantitative stresses. The yield loss of around 30-40% is attributed to Insect pests alone which are considered the most important limiting factor (Abbas et al., 2015). There are 1326 species of insect pests were found in the world, but DCB is the pest of cotton and okra. Its damage can be reduced by using the management practices as used for the bollworms (Akram, Asi, Mehfooz-ul-Haq, & Saleem, 2013). After the introduction of Bt-cotton in Pakistan, the number of sprays to the cotton crop is reduced and a lot of the farmer economy can be saved in this way, but it was also reported that Bt-cotton is not effective against sucking insects (Akram et al., 2013). Due to this reason the sucking insect pest population was increased drastically during recent years. By using the management practices such as early sowing and by the cultivation of the Bt-cotton in the country, the status of insect pest of the cotton was greatly changed (Aslam, Razaq, Shah, & Ahmad, 2004; Bergé & Ricroch, 2010).

Both qualitative and quantitative losses were observed in cotton due to an increase in the attack of dusky cotton bug which resulted in premature falling of squares/brackets, flowers, reduction in the seed weight, reduction in the germination percentage, and small bolls (Bakhsh, Hassan, & Maqbool, 2005). It can limit the value of the lint by crushing during the ginning process. Due to the attack of DCB on cotton, the oil content of the seed, cotton yield, and seed weight were also reduced up to 6, 6.8, and 32 percent, respectively (R. Khan & Naveed, 2017). This present study was carried out to determine both qualitative and quantitative losses caused by DCB in cotton. It feeds mainly on the seeds of cotton and causes severe damage to their tissues and reduces the viability (R. Khan & Naveed, 2017). It's feeding too places on the seeds of plants in the family Malvaceae but also reported on certain vegetables and fruits including avocado, apple, fig, grapes, dates, peach, pineapple, okra, and pomegranate. It became a dangerous pest in India, Southeast Asia, and Africa on both okra and cotton (Muthyala & Patil, 2003; Ullah, Shad, & Abbas, 2016). Seed viability was also reduced by the attack of the DCB. It is found that dusky cotton bugs cause 40.8%, 42.9%, 35.1%, and 29.3% losses in seed weight, seed cotton weight, oil content, and seed germination respectively. By the passing years, DCB becomes more problematic in cotton than before and known as a minor pest. In many countries around the world, it can become a major pest of cotton owing to potential losses it can inflict to cotton crops (Sammaiah, Laxman, & Samatha, 2012). It can decrease cotton seed germination, weight, and reduction in oil quality besides DCB being crushed during the ginning the viability (R. Khan & Naveed, 2017). process and stained the lint of cotton to pinkish colour (Sammaiah et al., 2012). With the increasing level of awareness about the damages caused by DCB, the need for its management is gaining momentum. At present, the only option available to the farmers is the application of chemical insecticides (Shah, Ali, Haq, & Hafeez, 2016). Other options including biocontrol are limited. Therefore, it is necessary to screen the most effective insecticides against (DCB).

Literature Review

It is evident from our study that the population of DCB can speed up the damage of line discoloration, viability reduction of cotton seed, reduction in seed weight, and the quality of lint (Ahmed et al., 2015). These qualitative and quantitative losses due to damage of DCB are

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directly dependent upon the density of insects per plant (M. A. Khan et al., 2014). The generally mean by pooling DCB population on each variety for the whole season revealed that three varieties (CIM-599, CIM-602 & IUB-222) showed a significantly lower population (37.76, 37.87, 43.84) and two varieties (FH-142, MNH-886) gave the highest population (44.71, 46.81), respectively (Iqbal, Bhutta, Alqarni, Owayss, & Ansari, 2018). In contrast to our results of DCB, Shahid et al. (2017) reported that two cotton cultivars (MNH-886 and FH- 142) that possessed the smallest population of another strainer (red cotton bug) in comparison with transgenic varieties other local native verities than of our study (Shahid, Farooq, Shakeel, Mahmood, & Gogi, 2017).

DCB attained the status of major cotton pest among all Bt varieties bear difference DCB population and observed no variety was free from the attack of DCB which is affirmative with DCB existence on different Bt varieties in the different experimental setup (M. A. Khan et al., 2014; Men, Ge, Liu, & Yardim, 2003; B. V. Patil, Bheemanna, & Hanchinal, 2007). The DCB population exhibited a significant negative correlation with temperature (including both limits maximum and minimum) and a positive significant correlation was determined with relative humidity these results are in-line with Hameed and co-workers (Hameed, Shahzad, Mehmood, & Ahmad, 2014) but these results are contradicted with the findings of two separate research groups (Srinivas & Patil, 2010; Ullah et al., 2016). The population DCB is increased with the higher relative humidity substituted by low temperature. The rainfall had non-significant negative correlation with the population dynamics of DCS (Iqbal et al., 2018; Qayyoum, Khan, Khan, Ghafar, & Bashir, 2014). The temperature and humidity are crucial factors for the damage potential and development of DCB (Thangavelu, 1978). The population dynamics of DCB is considerably influenced by weather condition of the field (Qayyoum et al., 2014; Schaefer & Panizzi, 2000).

The life cycle of DCB is completely dependent on the field conditions (environmental parameters) and the stage of the host crop. The variation in population is changed during the different month of the season by changing both influencing factors. The seed quality of the cotton crop is considerably at stake due to severe infestation of DCB owing to damage of seed cotton embryo resultant in lower seed viability. The population dynamic of DCB was considerably rising in both genotypes (Bt and non- Bt cotton) due to low number of insecticides application for the control of bollworms (B. Patil & Rajanikanth, 2005). Dusky cotton bug becoming a potential threat to cotton crops due to heavy infestation in previous years, the issue of DCB is heading towards serious cotton issue in coming years. The immature seeds do not ripe due to extensive suction of sap by all instars of immature stages and adult that leads to un-ripe and low weighted seeds (Vennila, Biradar, Sabesh, & Bambawale, 2007). The estimated damage to cotton by the bug is 6.8 percent of yield loss, up to 32 percent in weight loss, and a 6 percent reduction in oil content.

Methodology

The research was carried out at Cotton Research Station Vehari (Punjab, Pakistan). Vehari is usually known as the “Hub of Cotton”. The treatments were selected in such a way that in some treatments pest was controlled with pesticides and without pesticide. 10X20 m field was selected. There were 3 replications under Randomized Complete Block Design with 3 treatments.

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T1: Net Cloth Treatment T2: Sprayed treatment T3: Unsprayed Treatment

The seed of cotton (*Gossypium hirsutum*) cultivars named VH 305, VH 363, VH 327, FH 183 was sown on April 02, 2017. The plots were sprayed at the recommended doses after calibration to evaluate the quantity of water required as well as the actual quantity of pesticide required in the plot based on the area of the plot. The Cotton varieties were sown with 30 cm plant to plant and 75 cm row to row distance. Environmental data, maximum and minimum daily temperatures, and relative humidity were recorded round the year by the environmental station established by the CRS Vehari. To assess the effect of insecticides on DCB, two insecticides, Imidacloprid and chlorpyriphos were selected. A 500-ppm concentration of both the insecticides was prepared for field application. A one-year study was conducted during 2017 and 2018 to determine the losses caused by the Dusky cotton bug (*Oxycarenus laetus* Kirby) and their effect on seed germination, seed weight, and lint staining, etc. After the maturity of the bolls, the seeds were extracted from these bolls and 100 seeds were extracted from each sample to study the seed germination and seed weight reduction caused by a dusky cotton bug.

Results/Findings

Seed Germination percentage

After conducting the research, we concluded that there was significant variation among the treatments regarding percent seed germination during 2017-2018. We observed that maximum germination losses occur when the research area was kept unsprayed, resulting in minimum germination i.e., 57.94 percent and differed significantly when the research area kept sprayed and net cloth with 62.86 and 73.99 percent germination, respectively. The treatment followed as-sprayed, unsprayed, and net cloth showing 75.99%, 70.44%, and 55.31% germination, respectively differed significantly with one another. It was obvious from the result that minimum germination of cotton seed was occurring when there was no spray done. The present findings are in broader sense can tally with those of Hill and Schaefer and Panizi who reported that dusky cotton bug may reduce cotton seed germination severely.

100 Seed Weight

By using the three different treatments such as sprayed, unsprayed, and net cloth we concluded that dusky cotton bug put significant effect on 100-seed weight and percentage reduction in 100-seed weight under field conditions. We observed that the maximum 100-seed weight reduction occurred under the unsprayed conditions as compared to sprayed and net cloth treatment where minimum 100-seed weight reduction. The 100-seed weight decreased with an increase in the density of the dusky cotton bugs. Similarly, percent reduction in 100-seed weight over control ranged from 9.6% to 29.5% and increased with an increase in the density of dusky cotton bug.

Total Bolls per Plants

After experimenting, we observed that maximum bolls per plant are obtained under sprayed conditions. Among the Four Cultivars e.g., VH-305 gave extra ordinary results under sprayed

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conditions about 36%. Whereas net cloth treatment also provides significant results sprayed treatment provides us the required results.

Total Yield per Plant

By using the three treatments such as spraying, unsprayed, and net cloth, we find the reduction in seed cotton yield caused by the dusky cotton bug. The maximum reduction in the seed cotton yield was highest (42.97%) in the treatment with the unsprayed conditions, whereas minimum reduction in the seed cotton yield (8.98%) was observed with the sprayed condition. Maximum percent reduction of seed weight with 40 .84 was recorded in the treatment with unsprayed condition, but, minimum (7.32%) was recorded with sprayed condition.

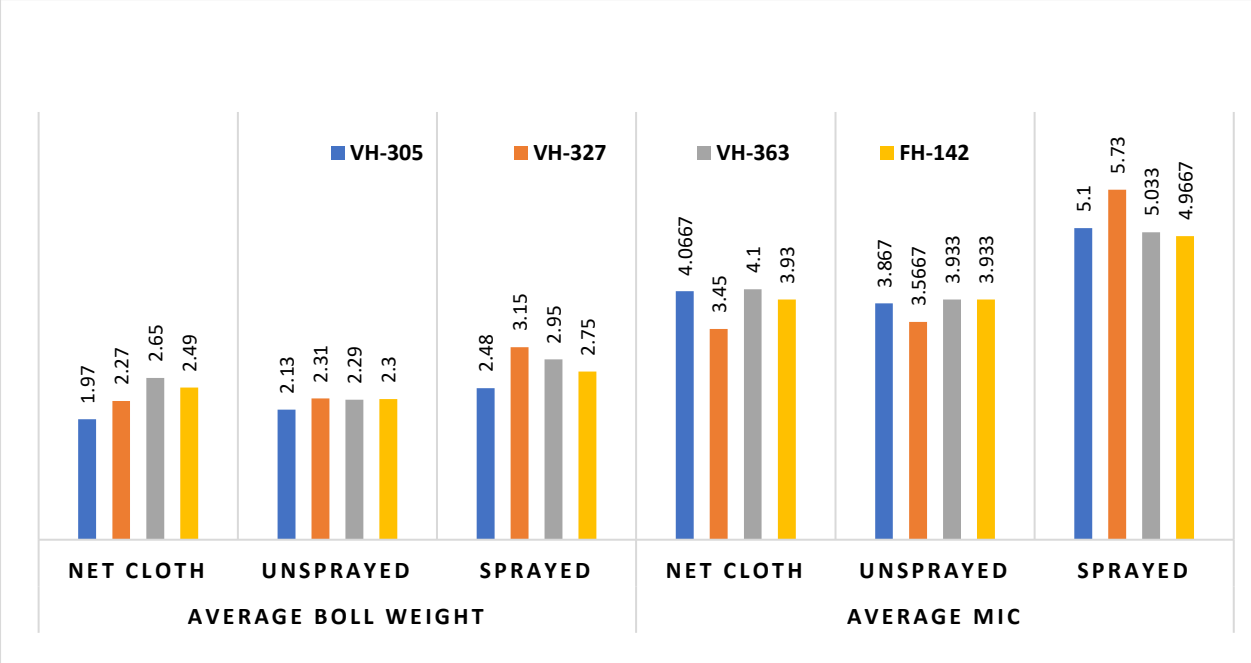

Figure 1: Different Parameters affected by Dusky Cotton Bug

Average Boll Weight

By using the three treatments such as spraying, unsprayed, and net cloth, we find the reduction in Average Boll Weight caused by the dusky cotton bug. The maximum Average Boll Weight was 35% in the treatment with the sprayed condition, whereas minimum Average Boll weight of 20% was observed with the unsprayed condition.

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Average Strength

The results show a significant variation for the following character. It was apparent from the results that the maximum fiber strength comes under the sprayed treatment. All the varieties give the best result under the sprayed condition and perform very badly under the unsprayed condition all 4 varies respectively.

Ginning Out Turn (GOT)

After conducting the research, we concluded that there was a negative effect of dusky cotton bug on the ginning out turn in cotton in all the varieties used in experiment. The maximum reduction in the GOT was noted in the unsprayed treatment in all the varieties and the minimum reduction take place under sprayed treatment.

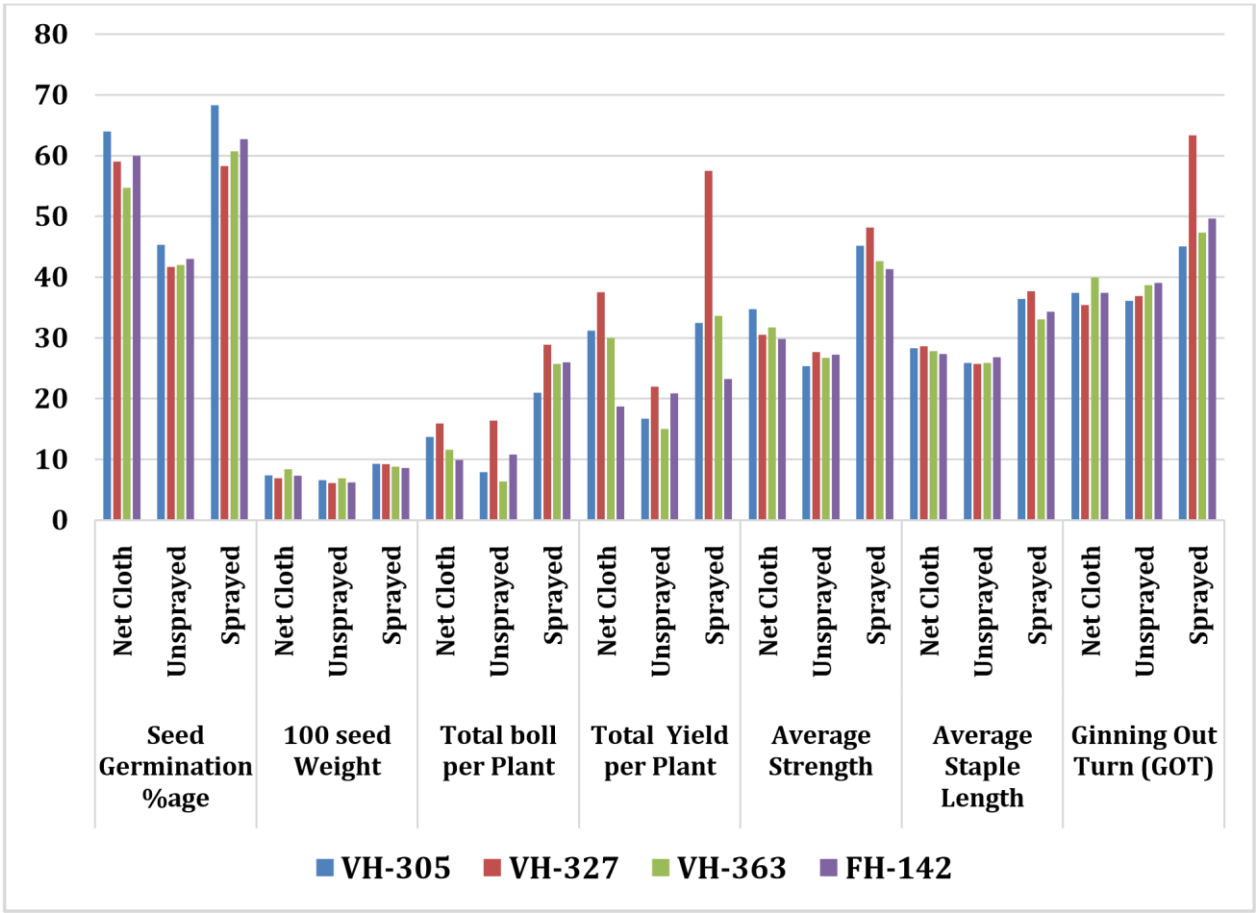

Figure 2: Different Parameters of Cotton Affected by Dusky Cotton Bug

Average Staple Length

It was concluded from the experiment that the staple length of cotton fiber was greatly affected by the dusky cotton bug. All the varieties show the significant variation about this character under all three treatments. Maximum staple length was noted under sprayed conditions.

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Average MIC

The results show a significant variation for the following character. It was apparent from the results that the maximum fiber highness comes under the sprayed treatment (10.9) mean fine fiber. All the varieties give the best result under the sprayed condition and perform very badly under the unsprayed condition all 4 varies respectively.

Per acre yield:

The result showed the significant variation for the yield per acre as the maximum per acre yield was obtained under the sprayed condition due to less damage caused by the dusky cotton bud in sprayed treatment. Per acre yield contributed by the number bolls, boll weight, and many other factors which were performed best under the sprayed condition.

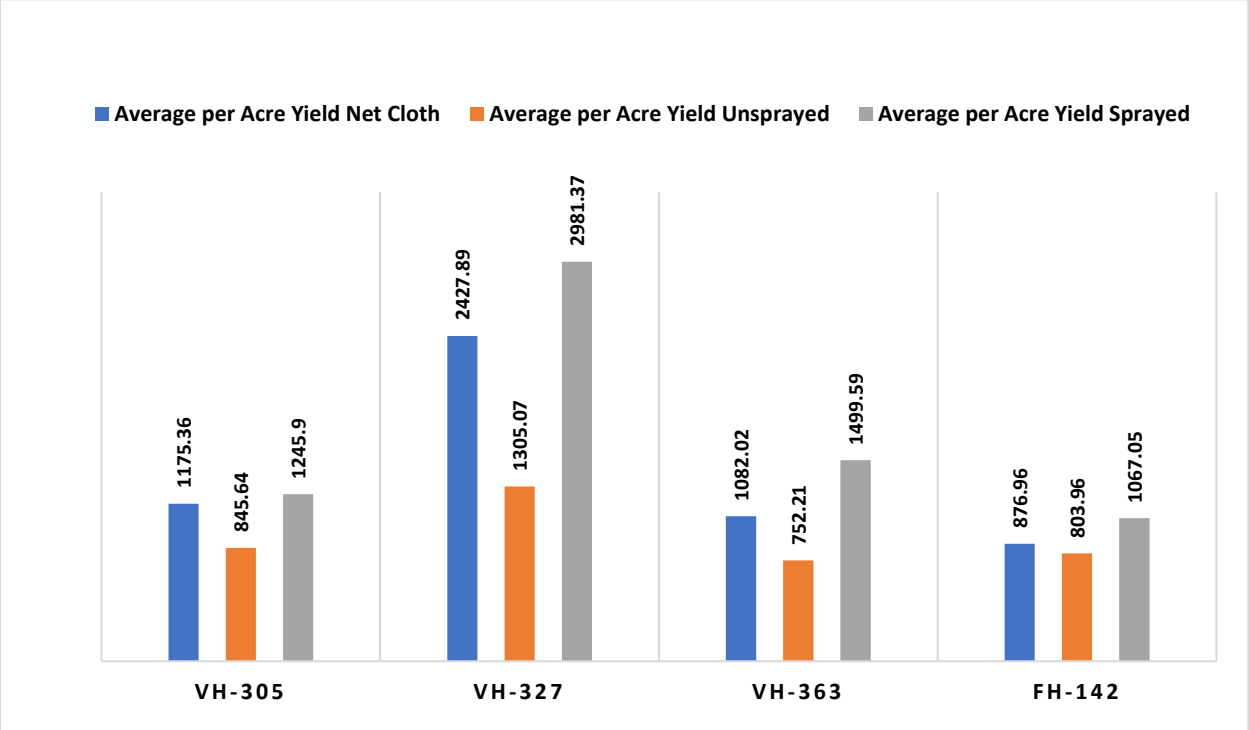

Figure 3: Average Per Acre Yield

Discussion/Analysis

The comparative study of four cotton cultivars (VH 305, VH 363, VH 327, FH 183) was performed for the control of dusky cotton bug (Oxycarenus spp.). Different management practices were adopted including two insecticides (Imidacloprid and chlorpyriphos) for the control of dusky cotton bugs. The environmental conditions were also considered including the fluctuation in temperature and relative humidity. Dusky cotton bug is having the status on minor pest in cotton insect pests. The damage is usually poor lint quality and poor viability of the seed. Farmers usually ignore the pest population fluctuation in the field due to status of minor pest, but the pest population is abruptly increased in the field in favorable environmental conditions. The cotton minor pests including dusky cotton bug change their status by increasing the population during the supportive a-biotic factors especially temperature and humidity. As

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our weather conditions usually supportive to insects in maintenance of higher population in the field helps the pest to keep their population above damaging boundaries. They usually never reach to injury level but due to supportive temperature and humidity conditions, they keep their population between damaging boundaries and injury level. DCB attained the status of major cotton pest among all Bt varieties bear difference DCB population and observed no variety was free from the attack of DCB which is affirmative with DCB existence on different Bt varieties in the different experimental setup (M. A. Khan et al., 2014; Men et al., 2003; B. V. Patil et al., 2007). The DCB population exhibited a significant negative correlation with temperature (including both limits maximum and minimum) and a positive significant correlation was determined with relative humidity these results are in-line with Hameed and co-workers (Hameed et al., 2014), but these results are contradicted with the findings by two separate research groups (Srinivas & Patil, 2010; Ullah et al., 2016). The population DCB is increased with the higher relative humidity substituted by low temperature. The rainfall had a non-significant negative correlation with the population dynamics of DCS (Iqbal et al., 2018; Qayyoum et al., 2014). The temperature and humidity are crucial factors for the damage potential and development of DCB (Thangavelu, 1978). The population dynamics of DCB is considerably influenced by weather condition of the field (Qayyoum et al., 2014; Schaefer & Panizzi, 2000). The incidence and population density of dusky cotton bug as other insects depend upon abiotic factors. Among these abiotic factors, the temperature is the most limiting factor which governed the growth and development of insect life cycle and therefore plays a vital role in increased population density of the pest (Weisser, Volkl, & Hassell, 1997). All life stages of DCB like nymphs and adults feed expressively on immature seeds which do not ripe and remain light in weight. The cotton seed was more seriously affected by DCB due to their extensive attack on cotton seed resulting in to compromised seed viability. The results in fig. 2 regarding 100-seed weight reveal significant difference among treatments and especially the viability is considerably affected by dusky cotton. Significant difference was also recorded among treatments regarding 100-seed weight during 2018 (Fig. 2). The maximum 100-seed weight was recorded to be 7.13g in the control treatment and differed significantly from those observed in all other treatments. Our results of a field bioassay are in line with (Srinivas & Patil, 2010). Their results also showed steady decline in DCB population after the use of imidacloprid and chlorpyriphos with the latter being more effective in a field experiment. In another field experiment (Abbas, Hassan, Farhan, Haq, & Karar, 2014; Abbas et al., 2015) chlorpyriphos was ranked the highest compared to other insecticides such as lamdacyhalothrin, nitenpiram and spintoram, respectively. The previous studies reports the DCB population decline from 24 to 4 per boll after first spray and 1.11 per boll after the second spray with chlorpyriphos (Abbas et al., 2015). By the passing years, DCB become more problematic in cotton than before and knows as a minor pest. In many countries round the world, it has the ability to become a major pest of cotton owing to potential losses it can inflict to cotton crop (Sammaiah et al., 2012). It has the ability to decrease cotton seed germination, weight and reduction in oil quality besides DCB being crushed during the ginning process and stained the lint of cotton to pinkish color (Sammaiah et al., 2012). With the increasing level of awareness about the damages caused by DCB, the need for its management is gaining momentum. At present the only option available to the farmers is the application of chemical insecticides (Shah et al., 2016). Other options including biocontrol are limited. Therefore, it is necessary to screen most effective insecticides against DCB.

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Conclusion

Based on our results and previous investigations on population dynamics of dusky cotton bugs, it was found that cotton cultivars (VH-327) compared to other cotton cultivars (VH 305, VH 363, and FH 183) performed better in the field conditions. The treatments with the application of insecticides performed better as compared to other non-chemical techniques. The population dynamics of dusky cotton bug have significant relationship with a-biotic factors. The damage is usually poor lint quality and poor viability of seed. The cotton minor pests including dusky cotton bug change their status by increasing the population during the supportive a-biotic factors especially temperature and humidity. As our weather conditions usually supportive to insects in maintenance of higher population in the field helps the pest to keep their population above damaging boundaries.

Authors Contribution

Dr. Muhammad Rizwan Ashraf wrote the manuscript, Dr. Asher Masroor helped in statistics and graphs, Dr. Shabbir Ahmad helped in manuscript preparation and proofreading, Mr. Shoukat Zaman Khan, and Mr. Kamran Javed conducted the field experiment and result analysis.

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Conflict Of Interest

The Authors declare no conflict of interest with anyone.

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